

Technical Memorandum

TO: Brenda Shine, Refining and Chemicals Group, SPPD

FROM: Eric Goehl, Environmental Protection Specialist
Refining and Chemicals Group, SPPD (E143-01)

DATE: July 11, 2012

SUBJECT: Summary of Cooling Water Systems Emission Source Test Reports

I. Purpose

The objective of this document is to provide a summary of the cooling water systems emission source test reports received by the EPA from the 2011 Information Collection Request (ICR) of the petroleum refinery industry.

II. Background

On April 1, 2011, the EPA sent an ICR to facilities in the U.S. petroleum refining industry. The ICR was comprehensive and designed to collect information on processing characteristics, crude slate characteristics, emissions inventories and source testing to bolster our current data and fill known data gaps. The ICR had four components: (1) a questionnaire on processes and controls to be completed by all petroleum refineries (Component 1); (2) an emissions inventory to be developed by all petroleum refineries using the emissions estimation protocol developed for this effort (Component 2); (3) distillation feed sampling and analysis to be conducted by all petroleum refineries (Component 3); and (4) emissions source testing to be completed in accordance with an EPA-approved protocol for specific sources at specific petroleum refineries (Component 4).

Component 4 of the ICR requested source testing for twelve different types of emission sources or units: fluid catalytic cracking units (FCCU), thermal catalytic cracking units, catalytic reforming units, sulfur recovery units, delayed coking units, fluid coking units, hydrocracking units, hydrogen plants, asphalt blowing units, fuel gas systems, cooling water systems, and wastewater treatment systems. This memorandum summarizes the results of the cooling water systems source tests. A similar memorandum is available for the other emission sources required to be tested as a result of this ICR.

Facilities often claimed specific process information as CBI, and included that information in the CBI version of the emission source test report stored in the EPA's CBI office in Research Triangle Park, NC. However, emissions data cannot be claimed as CBI. This memorandum summarizes and presents only non-CBI data.

III. Source-specific Testing Program

Below is a list of facilities required to test their cooling water systems:

- Suncor Energy (U.S.A.) Inc. Commerce City Refinery – Commerce City, CO (CO4A0340)
- Alon USA Krotz Springs Refinery – Krotz Springs, LA (LA3C0700)
- Western Refining Gallup Refinery – Jamestown, NM (NM3E0880)
- Wynnewood Refining Company – Wynnewood, OK (OK2C0960)
- United Refining Co – Warren, PA (PA1B1050)
- Valero McKee Refinery – Sunray, TX (TX3A1300)
- Pasadena Refining System Inc. – Pasadena, TX (TX3B1150)
- Holly Refining & Marketing Company - Woods Cross Refinery – Woods Cross, UT (UT4A1380)
- BP West Coast Products LLC – Blaine, WA (WA5A1400)
- Murphy Oil USA, Inc. Superior Refinery – Superior, WI (WI2B1460)
- Frontier Refining, Inc. – Cheyenne, WY (WY4A1470)

Owners or operators of the cooling water systems at these facilities were required to test for total strippable volatile organic compounds (VOC) using Modified El Paso Method (Air Stripping Method for Determination of Volatile Organic Compound Emissions from Water Sources, Revision Number One, dated January 2003, Sampling Procedures Manual, Appendix P: Cooling Tower Monitoring, prepared by Texas Commission on Environmental Quality, January 31, 2003). Following Modified El Paso testing, additional testing was performed on the cooling water system with the highest total strippable hydrocarbon concentration, except for the following situations: if more than one cooling water system return line had total strippable hydrocarbon concentration greater than 62 ppmv, then the facility conducted additional testing for all cooling water systems that had a return line concentration greater than 62 ppmv; and if none of the cooling water system return lines had a total strippable hydrocarbon concentration

greater than or equal to 3 ppmv, then the facility conducted additional testing only for HCl and Cl₂ for any one cooling water system return line. The additional testing included:

- Speciated volatile organic hazardous air pollutants (HAP)
- Speciated semi-volatile organic HAP
- Formaldehyde
- Total hydrocarbons
- Methane
- Hydrogen chloride and chlorine

A summary of the testing each facility conducted is provided in Table 1. It appears that four facilities did not provide the results of Modified El Paso Method testing (NM3E0880, OK2C0960, WI2B1460, WY4A1470); however, these facilities did conduct other cooling water analysis.

Additional detail of the source testing requirements for the cooling water systems sources can be found at <http://www.epa.gov/ttn/atw/petref/petrefpg.html>.

The EPA required that the data collected from the emission source testing to be reported using the EPA Electronic Reporting Tool (ERT). The ERT is a Microsoft® Access database application. If the facility conducted testing using a method not currently supported by the ERT, such as the required testing for cooling towers, the facility was required to report the results in the Refinery Testing Supplement, a Microsoft® Excel spreadsheet. After completing the Refinery Testing Supplement, the refineries were also asked to submit an electronic copy of the emission test report, preferably in PDF format.

IV. Results

A list of the cooling water systems that were tested is provided in Table 2, and a summary of the emission results for the cooling water systems are provided in Table 3. In order to better characterize the reported data from the emission test reports, detection level information was provided in the attached summary spreadsheet. The following designations were used to describe the detection levels of the reported emissions data.

- DLL = Detection Level Limited = 1 or 2 runs below detection limit
- BDL = Below Detection Limit = All three runs are below detection limit
- No designation = All three runs are above detection limit

Table 1. Testing Conducted by Petroleum Refinery Facilities on Cooling Water Systems

Facility	Air							Water	
	Modified El Paso	Speciated Volatile Organic HAP (TO-15 or TO-14A)	Speciated Semi-Volatile Organic HAP (TO-13A)	Formaldehyde (TO-5 or TO-11A)	THC (TO-12)	CH4 (Method 18 or 320)	HCl, Cl ₂ (Method 26 or 26A)	Speciated Volatile Organic HAP (6200)	Speciated Semi-Volatile Organic HAP (6410)
(CO4A0340) Suncor Energy (U.S.A.) Inc. Commerce City Refinery – Commerce City	X	X	X	X	X	X	X	X (8260B)	X (8270C)
(LA3C0700) Alon USA Krotz Springs Refinery – Krotz Springs	X	X	X	X (TO-11)	X (mod. TO-14A)	X	X	X (8260B)	X (8270C)
(NM3E0880) Western Refining Gallup Refinery – Jamestown		X	X (8270)	X	X	X	X	X (6010B/6200)	X
(OK2C0960) Wynnewood Refining Company – Wynnewood		X	X	X	X	X	X	X	X
(PA1B1050) United Refining Co – Warren	X	X	X	X (TO-11)	X	X (ASTM D-1945)	X	X (8260B)	X (8270C)
(TX3A1300) Valero McKee Refinery – Sunray	X						X		
(TX3B1150) Pasadena Refining System Inc. – Pasadena	X						X		
(UT4A1380) Holly Refining & Marketing Company - Woods Cross Refinery – Woods Cross	X	X	X		X	X	X	X (6200/8260B)	X (6410/8270)
(WA5A1400) BP West Coast Products LLC – Blaine	X						X		
(WI2B1460) Murphy Oil USA		X	X	X	X	X	X	X (8260B)	X (8270C)
(WY4A1470) Frontier Refining							X		

Table 2. Cooling Water Testing Data Summary for Petroleum Refineries

Facility ID	Test Date	Cooling Tower ID (HE System)	Recirculation rate, gpm	CT Water Make-up Rate, gpm	Return Line Flow Rate, gpm
CO4A0340	6/8/2011	Y-2 (Plant 3 Cooling Tower Y-2)	3,500	50	NA
CO4A0340	6/9/2011	Y-1 (Plant 1 Cooling Tower Y-1)	50,000	500	NA
CO4A0340	6/9/2011	Y-3 (Plant 1 Cooling Tower Y-3)	50,000	500	NA
CO4A0340	6/9/2011	Y-4 (Plant 1 Cooling Tower Y-4)	50,000	500	NA
CO4A0340	6/8/2011	P2CT-1 (Plant 2 Cooling Tower)	20,000	260	NA
LA3C0700	8/31/2011	8206 (FCC Unit Cooling Tower)	NA	NA	33,800
LA3C0700	8/31/2011	8006 (Crude Unit Cooling Tower) *	NA	NA	26,000
NM3E0880	7/27/2011	CT-1 and CT-2 *	9,000	150	NA
OK2C0960	08/08/2011	Hydrocracker (Hydrocracker Cooling Tower) *	70,000	35	NA
PA1B1050	08/18/2011	West (sources from West side of plant) *	4,500	164	NA
PA1B1050	08/18/2011	East (sources from East and West side of plant - return line 1)	19,700	592	9850
PA1B1050	08/18/2011	East (sources from East and West side of plant - return line 2)	19,700	592	9850
TX3A1300	05/18/2011	Gas Plant CWT (East return F-21)	41,770	443	NA
TX3A1300	05/18/2011	CWT No. 1 (West return F-20)	62,300	348	NA
TX3A1300	05/18/2011	CWT No. 2 (North return F-47)	15,000	434	NA
TX3A1300	05/18/2011	CWT No. 2 (South return F-47)	15,000	434	NA
TX3A1300	08/26/2011	CWT No. 1 (East return F-20)	62,300	348	NA
TX3B1150	8/23/2011	CTWFUALK (for Alky 1 and Alky 2)	22,000	550	NA
TX3B1150	8/23/2011	CTWFUCPX (for Coker, Crude, FCC, Hydrotreater, Light Oil, LPG, Reformer No. 3, SRU, Szorb)	50,000	1,562	NA
TX3B1150	8/23/2011	CTWFUMTB (for UDEX)	6,000	90	NA
UT4A1380	8/2/2011	4	4,975	62	NA
UT4A1380	8/2/2011	6	4,116	39	NA
UT4A1380	8/2/2011	7	2,910	31	NA
UT4A1380	8/2/2011	8	9,219	123	NA
UT4A1380	8/4/2012	11 *	4,189	74	NA

Facility ID	Test Date	Cooling Tower ID (HE System)	Recirculation rate, gpm	CT Water Make-up Rate, gpm	Return Line Flow Rate, gpm
WA5A1400	7/22/2011	CT-1 (West Riser)	48,167	1,942	NA
WA5A1400	7/22/2011	CT-1 (East Riser)	32,561	1,942	NA
WA5A1400	7/22/2011	CT-2	47,667	10	NA
WI2B1460	6/14/2011	CT1 (for Green Gas Unit, FCCU, Alky Unit) *	9,000	135	NA
WI2B1460	6/15/2011	CT2 (Crude Unit, DUFs, Hydrobons, Platformer, SRU, Isom Unit, Tail Gas Treatment Unit, Benzene Splitter) *	10,500	140	NA
WY4A1470	8/19/2011	CT No.2	314	4	NA
WY4A1470	8/19/2011	CT No.2	314	4	NA

* Facility required to conduct detailed testing for these cooling towers.

Table 3. Cooling Water Testing Data Summary for Petroleum Refineries

Facility ID	Cooling Tower ID	Pollutant name	Pollutant class	Measured Concentration	units, ppmvd or ppmw	Designation	Test Method	MW	P (El Paso apparatus), in.Hg	b (strip air flow), mL/min	a (sample water flow), mL/min	T, C	Calculated C (water), ppmw [use half det limit for BDL]	Emissions, lb/day	Note
CO4A0340	Y-2	THC	Total strippable VOC	1.52	ppmvd		Modified El Paso	16.4	29.9	2500	125	32	1.991E-02	8.367E-01	1
CO4A0340	Y-1	THC	Total strippable VOC	0.03	ppmvd		Modified El Paso	16.4	29.9	2500	125	32	3.929E-04	2.359E-01	1
CO4A0340	Y-3	THC	Total strippable VOC	0.39	ppmvd		Modified El Paso	16.4	29.9	2500	125	32	5.108E-03	3.067E+00	1
CO4A0340	Y-4	THC	Total strippable VOC	0	ppmvd		Modified El Paso	16.4	29.9	2500	125	32	0.000E+00	0.000E+00	1
CO4A0340	P2CT-1 *	THC	Total strippable VOC	5.29	ppmvd		Modified El Paso	16.4	29.9	2500	125	32	6.928E-02	1.664E+01	1
CO4A0340	P2CT-1 *	Methane	Hydrocarbon	5.49	ppmvd		18	16.4	29.9	2500	125	32	7.190E-02	1.727E+01	1
CO4A0340	P2CT-1 *	THC	Surrogate	0.332	ppmvd		12	16.4	29.9	2500	125	32	4.348E-03	1.044E+00	1
CO4A0340	P2CT-1 *	HCl	Other Inorganic HAP	0.28	ppmvd		26	36.46	29.9	2500	125	32	8.152E-03	1.958E+00	1
CO4A0340	P2CT-1 *	Chlorine	Other Inorganic HAP	< 0.1	ppmvd	BDL	26	70.91	29.9	2500	125	32	2.831E-03	6.801E-01	1
CO4A0340	P2CT-1 *	Acetone **	Volatile Organic HAP	0.116	ppmvd		TO-15	58.08	29.9	2500	125	32	5.380E-03	1.292E+00	1
CO4A0340	P2CT-1 *	Acrolein	Volatile Organic HAP	0.0463	ppmvd		TO-15	56.06	29.9	2500	125	32	2.073E-03	4.979E-01	1
CO4A0340	P2CT-1 *	Benzene	Volatile Organic HAP	0.0295	ppmvd		TO-15	78.11	29.9	2500	125	32	1.840E-03	4.420E-01	1
CO4A0340	P2CT-1 *	1,3-Butadiene	Volatile Organic HAP	0.0018	ppmvd		TO-15	54.09	29.9	2500	125	32	7.775E-05	1.867E-02	1

Facility ID	Cooling Tower ID	Pollutant name	Pollutant class	Measured Concentration	units, ppmvd or ppmw	Designation	Test Method	MW	P (ElPaso apparatus), in.Hg	b (strip air flow), mL/min	a (sample water flow), mL/min	T, C	Calculated C (water), ppmw [use half det limit for BDL]	Emissions, lb/day	Note
CO4A0340	P2CT-1 *	Carbon disulfide	Volatile Organic HAP	0.00207	ppmvd		TO-15	76.14	29.9	2500	125	32	1.259E-04	3.023E-02	1
CO4A0340	P2CT-1 *	n-Hexane	Volatile Organic HAP	0.21	ppmvd		TO-15	86.18	29.9	2500	125	32	1.445E-02	3.471E+00	1
CO4A0340	P2CT-1 *	Methylene chloride	Volatile Organic HAP	0.00232	ppmvd		TO-15	84.93	29.9	2500	125	32	1.573E-04	3.779E-02	1
CO4A0340	P2CT-1 *	Toluene	Volatile Organic HAP	0.00305	ppmvd		TO-15	92.14	29.9	2500	125	32	2.244E-04	5.390E-02	1
CO4A0340	P2CT-1 *	Formaldehyde	Volatile Organic HAP	< 0.002	ppmvd	BDL	TO-11A	30.03	29.9	2500	125	32	2.398E-05	5.760E-03	1
LA3C0700	8206	THC	Total strippable VOC	< 0.2043	ppmvd	BDL	Modified El Paso	16.4	29.9	2500	125	40	1.305E-03	5.299E-01	
LA3C0700	8006 *	THC	Total strippable VOC	223.17	ppmvd		Modified El Paso	16.4	29.9	2500	125	41	2.839E+00	8.865E+02	
LA3C0700	8006 *	Methane	Hydrocarbon	45.23	ppmvd		18	16.4	29.9	2500	125	41	5.754E-01	1.797E+02	
LA3C0700	8006 *	THC (NMOC, as propane)	Surrogate	347	ppmvd		modified TO-14A	16.4	29.9	2500	125	41	1.322E+01	4.129E+03	8
LA3C0700	8006 *	HCl	Other Inorganic HAP	3.15	ppmvd		26	36.46	29.9	2500	125	41	8.909E-02	2.782E+01	
LA3C0700	8006 *	Chlorine	Other Inorganic HAP	3.58	ppmvd		26	70.91	29.9	2500	125	41	1.969E-01	6.149E+01	
LA3C0700	8006 *	Benzene	Volatile Organic HAP	0.383	ppmvd		TO-15	78.11	29.9	2500	125	41	2.321E-02	7.246E+00	
LA3C0700	8006 *	Carbon disulfide	Volatile Organic HAP	0.026	ppmvd		TO-15	76.14	29.9	2500	125	41	1.536E-03	4.795E-01	

Facility ID	Cooling Tower ID	Pollutant name	Pollutant class	Measured Concentration	units, ppmvd or ppmw	Designation	Test Method	MW	P (ElPaso apparatus), in.Hg	b (strip air flow), mL/min	a (sample water flow), mL/min	T, C	Calculated C (water), ppmw [use half det limit for BDL]	Emissions, lb/day	Note
LA3C0700	8006 *	Ethylbenzene	Volatile Organic HAP	0.095	ppmvd		TO-15	106.17	29.9	2500	125	41	7.824E-03	2.443E+00	
LA3C0700	8006 *	n-Hexane	Volatile Organic HAP	1.733	ppmvd		TO-15	86.18	29.9	2500	125	41	1.159E-01	3.618E+01	
LA3C0700	8006 *	Pentane **	Volatile Organic HAP	1.443	ppmvd		TO-15	72.15	29.9	2500	125	41	8.076E-02	2.522E+01	
LA3C0700	8006 *	Toluene	Volatile Organic HAP	0.548	ppmvd		TO-15	92.14	29.9	2500	125	41	3.917E-02	1.223E+01	
LA3C0700	8006 *	Xylenes (mixed)	Volatile Organic HAP	0.988	ppmvd		TO-15	106.17	29.9	2500	125	41	8.137E-02	2.541E+01	
LA3C0700	8006 *	Formaldehyde	Volatile Organic HAP	0.23	ppmvd		TO-11	30.03	29.9	2500	125	41	5.358E-03	1.673E+00	
NM3E0880	CT-1 and CT-2 *	THC	Surrogate	113.9	ppmvd		TO-12	16.4	NA	NA	NA	NA	3.273E+00	3.538E+02	2, 3
NM3E0880	CT-1 and CT-2 *	Methane	Hydrocarbon	< 1.00	ppmvd	BDL	18	16.4	29.9	2500	125	32	< 1.000E-02	5.404E-01	2
NM3E0880	CT-1 and CT-2 *	HCl	Other Inorganic HAP	< 0.027	ppmvd	BDL	26	36.46	29.9	2500	125	32	3.931E-04	4.248E-02	2, 5
NM3E0880	CT-1 and CT-2 *	Chlorine	Other Inorganic HAP	< 0.077	ppmvd	DLL	26	70.91	NA	NA	NA	NA	< 3.480E-03	1.881E-01	2, 3
NM3E0880	CT-1 and CT-2 *	1,3-Butadiene	Volatile Organic HAP	< 0.000333	ppmvd	DLL	TO-15	54.09	29.9	2500	125	32	1.438E-05	1.555E-03	2
NM3E0880	CT-1 and CT-2 *	Pentane **	Volatile Organic HAP	1.47	ppmvd		TO-15	72.15	29.9	2500	125	32	8.470E-02	9.154E+00	4
NM3E0880	CT-1 and CT-2 *	n-Hexane	Volatile Organic HAP	1.53	ppmvd		TO-15	86.18	29.9	2500	125	32	1.053E-01	1.138E+01	2, 4
NM3E0880	CT-1 and CT-2 *	Benzene	Volatile Organic HAP	0.20	ppmvd		TO-15	78.11	29.9	2500	125	32	1.248E-02	1.348E+00	2, 4

Facility ID	Cooling Tower ID	Pollutant name	Pollutant class	Measured Concentration	units, ppmvd or ppmw	Designation	Test Method	MW	P (ElPaso apparatus), in.Hg	b (strip air flow), mL/min	a (sample water flow), mL/min	T, C	Calculated C (water), ppmw [use half det limit for BDL]	Emissions, lb/day	Note
NM3E0880	CT-1 and CT-2 *	2,2,4-Trimethylpentane	Volatile Organic HAP	< 0.00233	ppmvd	DLL	TO-15	114.23	29.9	2500	125	32	2.125E-04	2.297E-02	2, 5
NM3E0880	CT-1 and CT-2 *	Toluene	Volatile Organic HAP	2.46	ppmvd		TO-15	92.14	29.9	2500	125	32	1.810E-01	1.956E+01	2, 4
NM3E0880	CT-1 and CT-2 *	Ethylbenzene	Volatile Organic HAP	1.17	ppmvd		TO-15	106.17	29.9	2500	125	32	9.920E-02	1.072E+01	2, 4
NM3E0880	CT-1 and CT-2 *	Xylene (m-, p-)	Volatile Organic HAP	2.36	ppmvd		TO-15	106.17	29.9	2500	125	32	2.001E-01	2.163E+01	2, 4
NM3E0880	CT-1 and CT-2 *	Xylene (o-)	Volatile Organic HAP	0.963	ppmvd		TO-15	106.17	29.9	2500	125	32	8.165E-02	8.825E+00	2, 4
NM3E0880	CT-1 and CT-2 *	Cumene	Volatile Organic HAP	0.000633	ppmvd		TO-15	120.19	29.9	2500	125	32	6.075E-05	6.567E-03	2
NM3E0880	CT-1 and CT-2 *	Naphthalene	Volatile Organic HAP	0.0289	ppmvd		TO-15	128.17	29.9	2500	125	32	2.958E-03	3.197E-01	2, 4
NM3E0880	CT-1 and CT-2 *	Formaldehyde	Volatile Organic HAP	0.0007	ppmvd		TO-11A	30.03	NA	NA	NA	NA	1.337E-05	1.445E-03	2, 3
NM3E0880	CT-1 and CT-2 *	Naphthalene	Semi-Volatile/Non-Volatile Organic HAP	< 0.00269	ppmvd	DLL	8270C	128.17	29.9	2500	125	32	2.753E-04	2.976E-02	2
NM3E0880	CT-1 and CT-2 *	2-Methylnaphthalene	Semi-Volatile/Non-Volatile Organic HAP	0.00998	ppmvd		8270C	142.2	29.9	2500	125	32	1.133E-03	1.225E-01	2
NM3E0880	CT-1 and CT-2 *	Pentane **	Volatile Organic HAP	0.17762	ppmw		6010B, 6200	72.15	NA	NA	NA	NA	Compare with value calc above from measured air conc.	1.920E+01	9

Facility ID	Cooling Tower ID	Pollutant name	Pollutant class	Measured Concentration	units, ppmvd or ppmw	Designation	Test Method	MW	P (ElPaso apparatus), in.Hg	b (strip air flow), mL/min	a (sample water flow), mL/min	T, C	Calculated C (water), ppmw [use half det limit for BDL]	Emissions, lb/day	Note
NM3E0880	CT-1 and CT-2 *	Methylene chloride	Volatile Organic HAP	0.0245	ppmw		6010B, 6200	84.93	NA	NA	NA	NA	NA	2.648E+00	5, 9
NM3E0880	CT-1 and CT-2 *	n-Hexane	Volatile Organic HAP	0.12107	ppmw		6010B, 6200	86.18	NA	NA	NA	NA	Compare with value calc above from measured air conc.	1.309E+01	9
NM3E0880	CT-1 and CT-2 *	Benzene	Volatile Organic HAP	0.0222	ppmw		6010B, 6200	78.11	NA	NA	NA	NA	Compare with value calc above from measured air conc.	2.400E+00	9
NM3E0880	CT-1 and CT-2 *	Toluene	Volatile Organic HAP	0.219	ppmw		6010B, 6200	92.14	NA	NA	NA	NA	Compare with value calc above from measured air conc.	2.367E+01	9
NM3E0880	CT-1 and CT-2 *	Ethylbenzene	Volatile Organic HAP	0.07125	ppmw		6010B, 6200	106.17	NA	NA	NA	NA	Compare with value calc above from measured air conc.	7.701E+00	9
NM3E0880	CT-1 and CT-2 *	Xylene (m-, p-)	Volatile Organic HAP	0.193	ppmw		6010B, 6200	106.17	NA	NA	NA	NA	Compare with value calc above from measured air conc.	2.086E+01	9
NM3E0880	CT-1 and CT-2 *	Xylene (o-)	Volatile Organic HAP	0.1396	ppmw		6010B, 6200	106.17	NA	NA	NA	NA	Compare with value calc above from measured air conc.	1.509E+01	9
NM3E0880	CT-1 and CT-2 *	Styrene	Volatile Organic HAP	< 0.00493	ppmw	DLL	6010B, 6200	104.15	NA	NA	NA	NA	NA	5.329E-01	5, 9

Facility ID	Cooling Tower ID	Pollutant name	Pollutant class	Measured Concentration	units, ppmvd or ppmw	Designation	Test Method	MW	P (ElPaso apparatus), in.Hg	b (strip air flow), mL/min	a (sample water flow), mL/min	T, C	Calculated C (water), ppmw [use half det limit for BDL]	Emissions, lb/day	Note
NM3E0880	CT-1 and CT-2 *	Naphthalene	Volatile Organic HAP	< 0.01547	ppmw	DLL	6010B, 6200	128.17	NA	NA	NA	NA	Compare with value calc above from measured air conc.	1.672E+00	9
OK2C0960	Hydrocracker *	Methane	Hydrocarbon	4.65	ppmvd		18	16.4	NA	NA	NA	NA	5.610E-03	4.716E+00	3
OK2C0960	Hydrocracker *	THC	Surrogate	3.44	ppmvd		TO-12	16.4	NA	NA	NA	NA	4.240E-03	3.564E+00	3
OK2C0960	Hydrocracker *	Formaldehyde	Aldehydes	< 0.000531	ppmvd	DLL	TO-11A	30.03	NA	NA	NA	NA	1.030E-06	8.659E-04	3
OK2C0960	Hydrocracker *	HCl	Other Inorganic HAP	< 0.00647	ppmvd	BDL	26	36.46	NA	NA	NA	NA	< 1.600E-05	1.345E-02	3
OK2C0960	Hydrocracker *	Chlorine	Other Inorganic HAP	< 0.0068	ppmvd	DLL	26	70.91	NA	NA	NA	NA	2.840E-04	2.388E-01	3
OK2C0960	Hydrocracker *	Acrolein	Volatile Organic HAP	0.0148	ppmvd		TO-15	56.06	28.95	2500	125	32	6.415E-04	5.393E-01	2
OK2C0960	Hydrocracker *	Acetone **	Volatile Organic HAP	0.22	ppmvd		TO-15	58.08	28.95	2500	125	32	9.879E-03	8.305E+00	2, 4
OK2C0960	Hydrocracker *	Carbon disulfide	Volatile Organic HAP	0.00129	ppmvd		TO-15	76.14	28.95	2500	125	32	7.594E-05	6.384E-02	2
OK2C0960	Hydrocracker *	Methylene chloride	Volatile Organic HAP	0.00166	ppmvd		TO-15	84.93	28.95	2500	125	32	1.090E-04	9.164E-02	2, 4
OK2C0960	Hydrocracker *	n-Hexane	Volatile Organic HAP	0.011	ppmvd		TO-15	86.18	28.95	2500	125	32	7.330E-04	6.162E-01	2
OK2C0960	Hydrocracker *	Chloroform	Volatile Organic HAP	0.0118	ppmvd		TO-15	119.38	28.95	2500	125	32	1.089E-03	9.156E-01	2
OK2C0960	Hydrocracker *	Benzene	Volatile Organic HAP	0.0071	ppmvd		TO-15	78.11	28.95	2500	125	32	4.288E-04	3.605E-01	2, 4

Facility ID	Cooling Tower ID	Pollutant name	Pollutant class	Measured Concentration	units, ppmvd or ppmw	Designation	Test Method	MW	P (ElPaso apparatus), in.Hg	b (strip air flow), mL/min	a (sample water flow), mL/min	T, C	Calculated C (water), ppmw [use half det limit for BDL]	Emissions, lb/day	Note
OK2C0960	Hydrocracker *	Methyl methacrylate	Volatile Organic HAP	0.000706	ppmvd		TO-15	86.09	28.95	2500	125	32	4.699E-05	3.951E-02	2
OK2C0960	Hydrocracker *	Toluene	Volatile Organic HAP	0.00946	ppmvd		TO-15	92.14	28.95	2500	125	32	6.739E-04	5.666E-01	2, 4
OK2C0960	Hydrocracker *	1,1,2-Trichloroethane	Volatile Organic HAP	0.000586	ppmvd		TO-15	133.41	28.95	2500	125	32	6.045E-05	5.082E-02	2
OK2C0960	Hydrocracker *	Ethylbenzene	Volatile Organic HAP	0.00322	ppmvd		TO-15	106.17	28.95	2500	125	32	2.643E-04	2.222E-01	2
OK2C0960	Hydrocracker *	Xylene (m-, p-)	Volatile Organic HAP	0.00291	ppmvd		TO-15	106.17	28.95	2500	125	32	2.389E-04	2.008E-01	2
OK2C0960	Hydrocracker *	Xylene (o-)	Volatile Organic HAP	0.00105	ppmvd		TO-15	106.17	28.95	2500	125	32	8.619E-05	7.246E-02	2
OK2C0960	Hydrocracker *	Acetone **	Volatile Organic HAP	0.28	ppmw		6410	58.08	NA	NA	NA	NA	Compare with value calc above from measured air conc.	2.354E+02	9
OK2C0960	Hydrocracker *	Benzene	Volatile Organic HAP	0.00028	ppmw		6410	78.11	NA	NA	NA	NA	Compare with value calc above from measured air conc.	2.354E-01	9
OK2C0960	Hydrocracker *	Methylene chloride	Volatile Organic HAP	0.016	ppmw		6410	84.93	NA	NA	NA	NA	Compare with value calc above from measured air conc.	1.345E+01	9
OK2C0960	Hydrocracker *	Pentane **	Volatile Organic HAP	0.00146	ppmw		6410	72.15	NA	NA	NA	NA	NA	1.227E+00	9
OK2C0960	Hydrocracker *	Toluene	Volatile Organic HAP	0.00051	ppmw		6410	92.14	NA	NA	NA	NA	Compare with value calc above from measured air conc.	4.287E-01	9

Facility ID	Cooling Tower ID	Pollutant name	Pollutant class	Measured Concentration	units, ppmvd or ppmw	Designation	Test Method	MW	P (El Paso apparatus), in.Hg	b (strip air flow), mL/min	a (sample water flow), mL/min	T, C	Calculated C (water), ppmw [use half det limit for BDL]	Emissions, lb/day	Note
PA1B1050	West *	VOC	VOC	5.64	ppmvd		Modified El Paso	16.4	30.07	2500	125	23	7.494E-02	6.480E+00	3, 6
PA1B1050	West *	Methane	Hydrocarbon	1.9	ppmvd		D1945	16.4	30.07	2500	125	23	2.580E-02	1.394E+00	
PA1B1050	West *	THC	Volatile Organic HAP	0.65	ppmvd		TO-12	16.4	30.07	2500	125	23	8.827E-03	4.771E-01	
PA1B1050	West *	Acetone **	Volatile Organic HAP	0.014	ppmvd		TO-15	58.08	30.07	2500	125	23	6.733E-04	3.639E-02	
PA1B1050	West *	2,2,4-Trimethylpentane	Volatile Organic HAP	0.057	ppmvd		TO-15	114.23	30.07	2500	125	23	5.392E-03	2.914E-01	
PA1B1050	West *	Trichloroethylene	Volatile Organic HAP	0.00071	ppmvd		TO-15	131.39	30.07	2500	125	23	7.725E-05	4.175E-03	
PA1B1050	West *	Toluene	Volatile Organic HAP	0.0022	ppmvd		TO-15	92.14	30.07	2500	125	23	1.679E-04	9.072E-03	
PA1B1050	West *	Xylene (m-, p-)	Volatile Organic HAP	0.00081	ppmvd		TO-15	106.17	30.07	2500	125	23	7.121E-05	3.849E-03	
PA1B1050	West *	Formaldehyde	Aldehydes	0.0041	ppmvd		TO-11A	30.03	29.1	2500	125	23	9.867E-05	5.332E-03	
PA1B1050	West *	HCl	Other Inorganic HAP	< 0.174	ppmvd	BDL	26	36.46	29.1	2500	125	23	2.542E-03	1.374E-01	
PA1B1050	West *	Chlorine	Other Inorganic HAP	< 0.083	ppmvd	BDL	26	70.91	29.1	2500	125	23	2.358E-03	1.274E-01	
PA1B1050	East (return line 1)	THC	Total strippable VOC	0.15	ppmvd		Modified El Paso	16.4	30.07	2500	125	29	2.000E-03	1.733E-01	3,6
PA1B1050	East (return line 2)	THC	Total strippable VOC	0.73	ppmvd		Modified El Paso	16.4	30.07	2500	125	29	9.530E-03	8.234E-01	3, 6
TX3A1300	Gas Plant CWT (East F-21)	THC	Total strippable VOC	0.4	ppmv		Modified El Paso	16.4	29.56	2500	129.2	34	5.000E-03	2.508E+00	3

Facility ID	Cooling Tower ID	Pollutant name	Pollutant class	Measured Concentration	units, ppmvd or ppmw	Designation	Test Method	MW	P (El Paso apparatus), in.Hg	b (strip air flow), mL/min	a (sample water flow), mL/min	T, C	Calculated C (water), ppmw [use half det limit for BDL]	Emissions, lb/day	Note
TX3A1300	Gas Plant CWT (East F-21)	HCl	Other Inorganic HAP	< 0.62	ppmv	BDL	26	36.46	26.41	2500	125	32	< 1.590E-02	7.976E+00	3
TX3A1300	Gas Plant CWT (East F-21)	Chlorine	Other Inorganic HAP	< 0.32	ppmv	BDL	26	70.91	26.41	2500	125	32	< 1.580E-02	7.926E+00	3
TX3A1300	Gas Plant CWT (West F-21)	THC	Total strippable VOC	0.3	ppmv		Modified El Paso	16.4	25.9	2500	132.5	34	3.000E-03	1.505E+00	3
TX3A1300	CWT No. 1 (West F-20)	THC	Total strippable VOC	0.3	ppmv		Modified El Paso	16.4	25.94	2500	122.5	34	3.500E-03	2.619E+00	3
TX3A1300	CWT No. 2 (North F-47)	THC	Total strippable VOC	0.4	ppmv		Modified El Paso	16.4	25.987	2483.3	120.8	23	5.000E-03	9.007E-01	3
TX3A1300	CWT No. 2 (South F-47)	THC	Total strippable VOC	0.9	ppmv		Modified El Paso	16.4	25.99	2466.7	115.8	24	1.100E-02	1.982E+00	3
TX3A1300	CWT No. 1 (East F-20)	THC	Total strippable VOC	0.4	ppmv		Modified El Paso	16.4	26.4	2500	125	39	3.900E-03	2.918E+00	3
TX3B1150	CTWFUA LK	THC	Total strippable VOC	< 0	ppmv	BDL	Modified El Paso	16.4	29.97	2500	125	40	0.000E+00	0.000E+00	
TX3B1150	CTWFUC PX	THC	Total strippable VOC	< 0	ppmvd	BDL	Modified El Paso	16.4	29.97	2500	125	41	0.000E+00	0.000E+00	
TX3B1150	CTWFU MTB	THC	Total strippable VOC	< 0	ppmvd	BDL	Modified El Paso	16.4	29.97	2500	125	43	0.000E+00	0.000E+00	
TX3B1150	CTWFU MTB	HCl	Other Inorganic HAP	0.00885	ppmvd		26	36.46	29.9	3480	125	39	1.210E-05	5.210E-02	3, 6

Facility ID	Cooling Tower ID	Pollutant name	Pollutant class	Measured Concentration	units, ppmvd or ppmw	Designation	Test Method	MW	P (El Paso apparatus), in.Hg	b (strip air flow), mL/min	a (sample water flow), mL/min	T, C	Calculated C (water), ppmw [use half det limit for BDL]	Emissions, lb/day	Note
TX3B1150	CTWFU MTB	Chlorine	Other Inorganic HAP	0.00031	ppmvd		26	70.91	29.9	3480	125	39	2.350E-05	1.015E-01	3, 6
UT4A1380	4	VOC	Total strippable VOC	1.8	ppmvd		Modified El Paso	16.4	25.84	2500	125	26	2.078E-02	1.242E+00	
UT4A1380	6	VOC	Total strippable VOC	24	ppmvd		Modified El Paso	16.4	25.84	2500	125	27	2.762E-01	1.365E+01	
UT4A1380	7	VOC	Total strippable VOC	12.2	ppmvd		Modified El Paso	16.4	25.85	2500	125	32	1.381E-01	4.828E+00	
UT4A1380	8	VOC	Total strippable VOC	3.4	ppmvd		Modified El Paso	16.4	25.85	2500	125	28	3.901E-02	4.319E+00	
UT4A1380	11 *	VOC	Total strippable VOC	1,941	ppmvd		Modified El Paso	16.4	25.75	2500	125	26	2.233E+01	1.123E+03	
UT4A1380	11 *	Methane	Hydrocarbon	0.57	ppmvd		18	16.4	25.75	2500	125	26	6.558E-03	3.299E-01	
UT4A1380	11 *	THC	Surrogate	2380	ppmvd		TO-12	16.4	25.75	2500	125	26	2.738E+01	1.378E+03	
UT4A1380	11 *	HCl	Other Inorganic HAP	0.466	ppmvd		26	36.46	25.75	2500	125	26	1.192E-02	5.996E-01	
UT4A1380	11 *	Chlorine	Other Inorganic HAP	< 0.537	ppmvd	BDL	26	70.91	25.75	2500	125	26	1.336E-02	6.719E-01	
UT4A1380	11 *	Acetone **	Volatile Organic HAP	0.11	ppmvd		TO-14A	58.08	25.75	2500	125	26	4.482E-03	2.255E-01	4
UT4A1380	11 *	Carbon disulfide	Volatile Organic HAP	0.023	ppmvd		TO-14A	76.14	25.75	2500	125	26	1.229E-03	6.180E-02	
UT4A1380	11 *	n-Hexane	Volatile Organic HAP	0.00079	ppmvd		TO-14A	86.18	25.75	2500	125	26	4.776E-05	2.403E-03	
UT4A1380	11 *	Methylene chloride	Volatile Organic HAP	0.0022	ppmvd		TO-14A	84.93	25.75	2500	125	26	1.311E-04	6.594E-03	4

Facility ID	Cooling Tower ID	Pollutant name	Pollutant class	Measured Concentration	units, ppmvd or ppmw	Designation	Test Method	MW	P (ElPaso apparatus), in.Hg	b (strip air flow), mL/min	a (sample water flow), mL/min	T, C	Calculated C (water), ppmw [use half det limit for BDL]	Emissions, lb/day	Note
UT4A1380	11 *	Pentane **	Volatile Organic HAP	0.04	ppmvd		TO-14A	72.15	25.75	2500	125	26	2.025E-03	1.019E-01	4
UT4A1380	11 *	Toluene	Volatile Organic HAP	0.0015	ppmvd		TO-14A	92.14	25.75	2500	125	26	9.696E-05	4.878E-03	4
UT4A1380	11 *	2,2,4-Trimethylpentane	Volatile Organic HAP	0.12	ppmvd		TO-14A	114.23	25.75	2500	125	26	9.616E-03	4.838E-01	4
UT4A1380	11 *	Formaldehyde	Aldehydes	0.00693	ppmvd		TO-11A	30.03	25.75	2500	125	26	1.460E-04	7.345E-03	
UT4A1380	11 *	Acetone **	Volatile Organic HAP	0.038	ppmw		6200, 8260B	58.08	NA	NA	NA	NA	Compare with value calc above from measured air conc.	1.912E+00	9, 10
UT4A1380	11 *	Cumene	Volatile Organic HAP	0.000072	ppmw		6200, 8260B	120.19	NA	NA	NA	NA	NA	3.622E-03	9, 10
UT4A1380	11 *	Ethylbenzene	Volatile Organic HAP	0.000045	ppmw		6200, 8260B	106.17	NA	NA	NA	NA	NA	2.264E-03	9, 10
UT4A1380	11 *	Methylene chloride	Volatile Organic HAP	0.00011	ppmw		6200, 8260B	84.93	NA	NA	NA	NA	Compare with value calc above from measured air conc.	5.534E-03	9, 10
UT4A1380	11 *	Pentane **	Volatile Organic HAP	0.0025	ppmw		6200, 8260B	72.15	NA	NA	NA	NA	Compare with value calc above from measured air conc.	1.258E-01	9, 10
UT4A1380	11 *	Toluene	Volatile Organic HAP	0.00013	ppmw		6200, 8260B	92.14	NA	NA	NA	NA	Compare with value calc above from measured air conc.	6.540E-03	9, 10

Facility ID	Cooling Tower ID	Pollutant name	Pollutant class	Measured Concentration	units, ppmvd or ppmw	Designation	Test Method	MW	P (El Paso apparatus), in.Hg	b (strip air flow), mL/min	a (sample water flow), mL/min	T, C	Calculated C (water), ppmw [use half det limit for BDL]	Emissions, lb/day	Note
UT4A1380	11 *	2,2,4-Trimethylpentane	Volatile Organic HAP	0.0069	ppmw		6200, 8260B	114.23	NA	NA	NA	NA	Compare with value calc above from measured air conc.	3.471E-01	9, 10
UT4A1380	11 *	Xylenes (mixed)	Volatile Organic HAP	0.0006	ppmw		6200, 8260B	106.17	NA	NA	NA	NA	NA	3.018E-02	9, 10
WA5A1400	CT-1 (West Riser)	VOC	VOC	0.11	ppmvd		Modified El Paso	16.4	29.9	2500	125	18	1.511E-03	8.740E-01	7
WA5A1400	CT-1 (East Riser)	VOC	VOC	0.26	ppmvd		Modified El Paso	16.4	29.9	2500	125	18	3.565E-03	1.394E+00	7
WA5A1400	CT-2	VOC	VOC	0.43	ppmvd		Modified El Paso	16.4	29.9	2500	125	18	5.896E-03	3.375E+00	7
WA5A1400	CT-2	HCl	Other Inorganic HAP	< 0.036	ppmvd	BDL	26	36.46	29.9	2500	125	18	< 5.487E-04	3.141E-01	7
WA5A1400	CT-2	Chlorine	Other Inorganic HAP	0.35	ppmvd		26	70.91	29.9	2500	125	18	2.075E-02	1.188E+01	7
WI2B1460	CT1 *	THC (as heptane)	Surrogate	0.17	ppmvd		TO-12	16.4	29.9	2500	125	32	1.113E-02	1.203E+00	2, 8
WI2B1460	CT1 *	Formaldehyde	Aldehydes	< 0.01	ppmvd	DLL	TO-11A	30.03	29.9	2500	125	32	2.398E-04	2.592E-02	2
WI2B1460	CT1 *	Methane	Hydrocarbon	< 10	ppmvd	BDL	18	16.4	29.9	2500	125	32	6.548E-02	7.078E+00	2
WI2B1460	CT1 *	HCl	Other Inorganic HAP	< 0.022	ppmvd	BDL	26	36.46	29.9	2500	125	32	3.203E-04	3.462E-02	2
WI2B1460	CT1 *	Chlorine	Other Inorganic HAP	0.043	ppmvd		26	70.91	29.9	2500	125	32	2.435E-03	2.632E-01	2
WI2B1460	CT1 *	Toluene	Volatile Organic HAP	0.0021	ppmvd		TO-15	92.14	29.9	2500	125	32	1.545E-04	1.670E-02	2

Facility ID	Cooling Tower ID	Pollutant name	Pollutant class	Measured Concentration	units, ppmvd or ppmw	Designation	Test Method	MW	P (ElPaso apparatus), in.Hg	b (strip air flow), mL/min	a (sample water flow), mL/min	T, C	Calculated C (water), ppmw [use half det limit for BDL]	Emissions, lb/day	Note
WI2B1460	CT1 *	Acetone **	Volatile Organic HAP	0.22	ppmw		8260B	58.08	NA	NA	NA	NA	NA	2.378E+01	9
WI2B1460	CT2 *	THC (as heptane)	Surrogate	0.24	ppmvd		TO-12	16.4	29.9	2500	125	32	1.572E-02	1.982E+00	2, 8
WI2B1460	CT2 *	Formaldehyde	Aldehydes	< 0.01	ppmvd	BDL	TO-11A	30.03	29.9	2500	125	32	1.199E-04	1.512E-02	2
WI2B1460	CT2 *	Methane	Hydrocarbon	< 10	ppmvd	BDL	18	16.4	29.9	2500	125	32	6.548E-02	8.257E+00	2
WI2B1460	CT2 *	HCl	Other Inorganic HAP	< 0.025	ppmvd	BDL	26	36.46	29.9	2500	125	32	3.639E-04	4.589E-02	2
WI2B1460	CT2 *	Chlorine	Other Inorganic HAP	< 0.013	ppmvd	BDL	26	70.91	29.9	2500	125	32	3.681E-04	4.641E-02	2
WI2B1460	CT2 *	Acetone **	Volatile Organic HAP	0.006	ppmvd		TO-15	58.08	29.9	2500	125	32	2.783E-04	3.509E-02	2
WI2B1460	CT2 *	Acrolein	Volatile Organic HAP	0.0012	ppmvd		TO-15	56.06	29.9	2500	125	32	5.372E-05	6.774E-03	2
WI2B1460	CT2 *	Benzene	Volatile Organic HAP	0.0008	ppmvd		TO-15	78.11	29.9	2500	125	32	4.990E-05	6.292E-03	2
WI2B1460	CT2 *	Carbon disulfide	Volatile Organic HAP	0.0014	ppmvd		TO-15	76.14	29.9	2500	125	32	8.512E-05	1.073E-02	2
WI2B1460	CT2 *	Ethylbenzene	Volatile Organic HAP	0.00057	ppmvd		TO-15	106.17	29.9	2500	125	32	4.833E-05	6.094E-03	2
WI2B1460	CT2 *	Toluene	Volatile Organic HAP	0.0096	ppmvd		TO-15	92.14	29.9	2500	125	32	7.064E-04	8.907E-02	2

Facility ID	Cooling Tower ID	Pollutant name	Pollutant class	Measured Concentration	units, ppmvd or ppmw	Designation	Test Method	MW	P (ElPaso apparatus), in.Hg	b (strip air flow), mL/min	a (sample water flow), mL/min	T, C	Calculated C (water), ppmw [use half det limit for BDL]	Emissions, lb/day	Note
WI2B1460	CT2 *	2-Nitropropane	Volatile Organic HAP	0.00075	ppmvd		TO-15	89.09	29.9	2500	125	32	5.336E-05	6.728E-03	2
WI2B1460	CT2 *	Xylenes (mixed)	Volatile Organic HAP	0.0032	ppmvd		TO-15	106.17	29.9	2500	125	32	2.713E-04	3.421E-02	2
WI2B1460	CT2 *	Pentane **	Volatile Organic HAP	0.0014	ppmvd		TO-15	72.15	29.9	2500	125	32	8.066E-05	1.017E-02	2
WY4A1470	CT No.2	HCl	Other Inorganic HAP	0.149	ppmvd		26	36.46	24.24	2700	125	29	3.834E-03	1.447E-02	
WY4A1470	CT No.2	Chlorine	Other Inorganic HAP	0.020	ppmvd		26	70.91	24.24	2700	125	29	1.001E-03	3.776E-03	

* Facility required to conduct detailed testing for these cooling towers.

** Not a HAP.

1 Facility did not provide a copy of the test report.

2 Red text indicates that the default values for flows specified in the method, atmospheric P, and average ambient temperature were used. For cooling water tests conducted in the Summer of 2011, assumed that the apparatus temperature was at least 90F (32C).

3 The facility calculated the concentration in the water based on the air concentration, and provided the value.

4 Compare to measured water concentration, below.

5 Compound was BDL in the measured air.

6 The facility calculated the mass emission rate and provided the value.

7 The facility provided calculated values for the water concentration and the mass emission rate, but there appeared to be a problem with the calculation (facility used 2.5 mL/min for the air flow rather than 2,500 mL/min).

8 Measured air concentration is not provided as methane; in determining the water concentration and the mass emission rate, the air concentration was converted to methane.

9 The emissions from the cooling tower are estimated based on the measured water concentration and the cooling tower water flowrate (see cooling tower flowrate values in Table 2); this estimate assumes that all of the compound present in the water volatilizes.

10 The test report for this cooling tower presents water concentrations in ug/L and shows these values as being equivalent to ppmw, however, there appeared to be a problem; we assumed the water concentrations were in ug/L and ppbw.